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Final Report

bd Systems, Inc.
Final Report
Contract No. NAS8-00114
Purchase Order No. NNM05AA34T, Task Order 36
Software Engineering Improvement Plan
Reporting Period: April 13, 2005 to April 12, 2006

Summary of Work Accomplished

In performance of this task order, bd Systems personnel provided support to the Flight Software Branch and the Software Working Group through multiple tasks related to software engineering improvement and to activities of the independent Technical Authority (iTA) Discipline Technical Warrant Holder (DTWH) for software engineering. To ensure that the products, comments, and recommendations complied with customer requirements and the statement of work, bd Systems personnel maintained close coordination with the customer. These personnel performed work in areas such as update of agency requirements and directives database, software effort estimation, software problem reports, a web-based process asset library, miscellaneous documentation review, software system requirements, issue tracking software survey, systems engineering NPR, and project-related reviews. This report contains a summary of the work performed and the accomplishments in each of these areas.

Software Engineering Improvement Support Activities

EI32 NPR/NPD Database

The Flight Software Branch (EI32) has a database containing the NASA Procedural Requirements (NPR) and the NASA Program Directives (NPD). bd Systems personnel performed the research and updated the current level of documentation in the database. In addition, the update to the EI32 database of the MSFC Marshall Work Instructions (MWIs), Marshall Policy Directives (MPDs), and Marshall Procedures and Guidelines (MPGs) to the current level of documentation was determined to be not feasible at the time due to the MSFC database not being updated to the current level of NASA documentation.

Software Project Estimator using COCOMO (SPEC)

The Software Project Estimator using COCOMO II (SPEC) was initially developed under a previous task. SPEC is an Excel-based application with a significant amount of Visual Basic macros. During this task, bd Systems personnel continued to test, correct problems, and enhance the SPEC product. Significant enhancements were made, particularly in the graphical display of projected effort and schedule results. To aid the user, an update of the printed and on-line documentation was implemented. Other related activities included performance of parameter studies to emphasize the importance of key parameters in influencing SPEC results. To validate the tool further, results were favorably

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compared with a JPL implementation of COCOMO II using Monte Carlo techniques. SPEC resides on the EI32 server and is available for use by EI32 personnel.

In support of the customer, bd Systems performed numerous estimates for projects such as the Crew Launch Vehicle and the Service Module. SPEC has proven to be a useful tool in performing project planning and systems engineering.

Activities related to the SPEC tool included an analysis of techniques for counting source lines of code (SLOC). Logical SLOC is the primary input in the COCOMO II model. The analysis included determining the detailed methodology in the tool used by the Flight Software Branch for counting code and comparing it with the definition for logical and physical lines of code contained in a technical report from the Software Engineering Institute. It was determined that the EI32 tool methodology is a combination of standard logical and physical lines of code. The organization may need to develop a concise definition of SLOC for the languages normally utilized.

Software Change Requests (SCR) Analysis

bd Systems personnel performed an update to a previously performed Software Change Report (SCR) analysis to include the 2005 SCRs. The goals for the analysis were to determine if the recommended changes made in the October 2004 report have been implemented and to update the metrics. The source of the data was the Merant database used for in-house programming projects. This database contained a total of 2031 SCRs. Factors in the analysis included SCRs by project, how long it took to close the SCR, the lifecycle phase in which the problem was injected, the lifecycle phase in which the problem was detected, how the problem was detected, and the cause of the problem. An effort was made to automate, to the extent possible, the Software Change Report (SCR) analysis and streamline the process of performing the SCR analysis so that the customer will be able to easily perform and/or update the analysis in the future. In summary, the process involves exporting the SCR information from the Tracker database into an Excel file, automatically creating defined databases containing the analysis data, and automatically updating the Word report from these databases. A report describing the process and the analysis was written and submitted to the customer.

PAL

The website for the software Process Asset Library (PAL) for the agency was developed initially by bd Systems under a previous task. Through this website, users at all NASA centers and headquarters can access and load content related to software development processes. During this task performance period, bd Systems continued to administer the website. Additional users from multiple NASA centers were approved and access was granted. Additionally, bd Systems personnel continued to add content, as requested by EI32 management. Metrics

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were periodically updated with respect to number of users, content loaded, and visits to the website.

iTA DTWH Support Activities

Software System Requirements for CLV

bd Systems personnel participated in an activity of compiling a set of flight software system requirements that will be applicable to the Crew Launch Vehicle (CLV). Using a previously compiled and categorized set of generic software system requirements from reviewing various documents such as the ELV Study Team, JPL Design Principles, X-37 OV, NPR 7150.2, CEV System Requirements, IEEE 12207, DO-178, etc., the initial set of requirements was compiled and discussed with EI30 and Software Safety personnel. The resultant requirements were proposed to be inserted into the CLV System Requirements Document (SRD) that was under review. bd Systems personnel participated in a tabletop review with EI and EV personnel of the CLV System Requirements Document (SRD) which accomplished the goal of determining which of the software system requirements should be included in the SRD and in which section. The suggested set of flight software system requirements was submitted to the project office. Subsequently, bd Systems personnel participated in a review with the project office in which the requirements were discussed in detail with personnel responsible for the CLV SRD. For those accepted for inclusion in the SRD, bd Systems personnel performed an allocation to the 1st stage, upper stage, and upper stage engine elements requirements. Additionally, rationale was developed for all of the new requirements. These products were submitted to the customer and to the EV Flight Software Branch chief. This activity continues but is perceived as being successful, to date, in getting software system requirements into the CLV SRD.

Issue Tracking Tools

bd Systems personnel participated in an activity of evaluating issue tracking software for use by the agency in tracking iTA issues. Several systems were evaluated and it was decided to develop a demonstration for NASA iTA personnel at MSFC and NASA Headquarters of a particular issue tracker, i. e. TeamTrack from Serena Software. An evaluation copy was obtained and installed, with the help of the UNITES contractor, on a web server. A demonstration was developed using the iTA RTF "watch list" data. This demonstration was presented to the customer, other MSFC management, and others at NASA Headquarters via Webex. The decision to fully implement an iTA issue tracker was postponed indefinitely, but the demonstration was successful.

DTWH Implementation Plan

bd Systems personnel supported the Discipline Technical Warrant Holder (DTWH) for software engineering in development of the Technical Warrant Holder Implementation Plan for Software Engineering document. This support

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included review of the plan, submitting comments and suggestions for changes to the DTWH, and, in some cases, implementing the changes. The resultant issue of this plan provides a good understanding of the scope, interfaces, processes, etc. for the DTWH for software engineering.

Centrifuge Rotor (CR) Flight Software

The CR is an ISS facility under development by the Japan Space Agency under the auspices of the Ames Research Center. At the request of the DTWH, bd Systems personnel reviewed CR software documentation and participated in teleconferences with the responsible ARC personnel. The documents included technical reports and assessments of the safety criticality of the CR flight software. Even though the IV&V center, that produced the documents, was limited in time and information, the reports were relatively thorough and conclusive that some of the CR software CSCIs are safety critical, which justified the involvement of the DTWH. Software requirements documents, produced by the Japan Space Agency, were received from ARC, as well as comments from ARC software personnel. These documents were reviewed and agreement with the ARC comments of their inadequacy was confirmed.

Systems Engineering NPR

At the request of the DTWH, bd Systems personnel participated in the review of the proposed Systems Engineering NPR at MSFC. Several meetings and teleconferences were supported to discuss comments and potential changes to the multiple versions of the NPR over the course of a few months. Subsequently, the NASA Systems Engineering Processes and Requirements, NPR 7123.1, was approved for implementation at the NASA centers. bd Systems personnel have reviewed MSFC implementation approach and evaluated the various existing Marshall Procedural Requirements (MPR) and Marshall Work Instructions (MWI) as to their adequacy, with regard to software, in this implementation approach.

Fluids Combustions Facility (FCF) Pre-Ship Review (PSR)

MSFC and bd Systems personnel participated in the FCF PSR at ZIN Technologies near the Glenn Research Center in December 2005. ZIN Technologies, the prime contractor, prepared and presented a large amount of FCF information at this review with a significant amount of this information being software-related. In summary, there is a lot of software supporting the Fluids Integrated Rack (FIR), the Combustion Integrated Rack (CIR), and the payloads, as well as ground support software. From the information presented and, otherwise, obtained at the review, the perception is that a sound software engineering process is in place for developing and verifying the software. However, at the time of the review, a significant amount of open work existed and there were some concerns about plans and resources for completing this work. A joint final report documented the review team's issues and concerns.

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Engineering Directorate (ED) Software Development Process Description Document

bd Systems personnel implemented modifications to the EI32 Software Development Process Description Document (SDPDD) with the intent of creating a 'strawman' SDPDD, i. e. Organization Work Instruction (OWI), applicable to all organizations in the Engineering Directorate (ED) that develop software. Major areas of consideration in the modifications included creation of an ED Software Engineering Process Group (SEPG) for improving software development processes, creation of an ED Process Assess Library (PAL), and introduction of processes for tailoring the software development process for an organization depending on the software class, as defined by the Software Engineering NPR. The initial version of this ED SDPDD was completed and submitted to the customer.

Miscellaneous

bd Systems personnel participated in a team, led by the DTWH, concerned with formulating an approach for development of the CLV flight software, from the organizational and functional standpoint. bd Systems participation consisted of technical input regarding the proper software engineering methodology for potential organizational and functional scenarios. Additional miscellaneous activities included review of numerous software-related documents and standards and submission of comments, either written or orally, during meetings and discussions with the various MSFC personnel and customers. An example of these activities is review of the Software Safety Standard and the Software Assurance Standard, the Software Safety Guidebook, and the Software Engineering Requirements NPR in order to reach an agreement on an opinion that a proposed NPR for Software Assurance was unnecessary. Other activities included participation in the CLV Avionics Architecture trade study.

In performance of this task, bd Systems personnel participated in the Flight Software Branch regular safety meetings and successfully completed training in mandatory courses such as IT Security, MSFC Environmental Management System and the Performance Evaluation Profile (PEP) Survey. Additionally, bd Systems personnel participated in the local annual Southeastern Software Engineering Conference.